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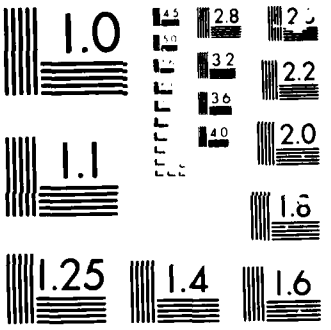
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USAFSAM-TR-86-7

# CENTRAL DENTAL COMPRESSED AIR (DCA) SYSTEMS

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May 1986

Interim Report for Period January 1985 - December 1985



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USAF SCHOOL OF AEROSPACE MEDICINE
Aerospace Medical Division (AFSC)
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The Office of Public Affairs has reviewed this report, and it is releasable to the National Technical Information Service, where it will be available to the general public, including foreign nationals.

This report has been reviewed and is approved for publication.

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19 ABSTRACT (*Continue on reverse if necessary and identify by block number*)

This report includes the minimum requirements for dental dental compressed air (DCA) systems and associated centrally plumbed distribution networks for use in Air Force dental health facilities. These specifications are interim until joint evaluations by the Dental Investigation Service and the Occupational and Environmental Health Laboratory establish standards for dental clinics.

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CONTENTS

# CENTRAL DENTAL COMPRESSED AIR (DCA) SYSTEMS

## 1. INTRODUCTION

1.1 Dental Compressed Air. Dental compressed air (DCA) is used for utility control in dental units and carts; power for lifts, locks, rotary, and other pneumatic dental instruments and equipment; and for surface preparation in all clinic and laboratory restorative and fabrication techniques. Dental compressed air is not used for breathing or respiratory support purposes of any kind, is not mixed with oxygen, and is not exhausted from powered instruments into the pharynx. Dental compressed air and the associated system and distribution network herein specified are a power source for dental equipment and procedures and are not an oilless medical air system. Therefore, National Fire Protection Association (NFPA) Standard 56F does not apply.

1.2 Minimum Requirements. The guidelines provided are minimum requirements for safe, proficient, reliable, and cost effective production and distribution of dental compressed air of the quality, pressures, and flow rates essential to dental health care delivery. The information provided is applicable to all DCA systems in new construction and system replacement projects and is intended to supplement and provide a basis for other design criteria, guide specifications, codes, and specifically Air Force Regulation 88-50, "Criteria for Design and Construction of Air Force Health Facilities."

## 2. DEFINITIONS

2.1 Dental Compressed Air (DCA). Local atmospheric air, compressed and refined to the quality, pressures, and flow rates defined in this document, specifically for use in dental facilities.

2.2 Standard Demand. The continuous rate of flow of dental compressed air expressed in cubic feet per minute (CFM) required to support the combined, normal air requirements of the dental clinic and laboratory.

2.3 Contingency Demand. The increased continuous rate of flow (CFM) of dental compressed air required to support the combined air requirements of the dental clinic and laboratory operating with increased staff and workload as a result of emergency or contingency situations. The contingency demand exists only for the extent of contingency operation.

2.4 Dental Compressed Air System. An assembly of compressors, aftercooler, separator, receiver, dryer, filters, regulator, and other electrical, mechanical and fluidic components and interconnections for the production, refinement, storage, monitoring, and initial regulation of dental compressed air; designed and sized for intermittent duty; and terminating at the point of connection to the dental compressed air central distribution network.

2.5 Station Pressure. The specified pressure, within specified tolerance, required at each station outlet of the centrally piped distribution network.

2.6 Minimum System Pressure. The lowest pressure required in the system to maintain the maximum specified station pressure, and at which pressure the system compressor(s) is (are) automatically switched on.

2.7 Maximum System Pressure. The highest pressure required in the system to provide the specified system pressure differential, and at which pressure the system compressor(s) is (are) automatically switched off.

2.8 System Pressure Differential. The specified pressure difference between minimum and maximum system pressures.

2.9 Mean System Pressure. The arithmetic average pressure between minimum and maximum system pressures.

2.10 System Duty Cycle. Total running time of the dental compressed air system per hour expressed as a percentage.

2.11 Centrally Piped Distribution Network. All central plumbing, in-line regulators, and individual station outlet fixtures for distribution of dental compressed air, originating at the system regulator outlet and terminating at the individual station fixture outlets.

2.12 Station Outlet Fixture. An endpoint of the centrally piped dental compressed air distribution network consisting of a manual valve of specified outlet type for user connection.

## 3. REQUIREMENTS

3.1 General. Dental compressed air, dental compressed air systems, and dental compressed air centrally piped distribution networks are designed specifically to support the professional requirements of dental clinics and laboratories, and (to protect planned efficacy and cost effectiveness) shall not be used for any other purpose.

3.2 Dental Compressed Air.

3.2.1 Dental compressed air is not recommended as drive air for specialized surgical handpieces designed for operation using nitrogen as a drive gas. Recommendations for a surgical handpiece drive air substitute for nitrogen are the subject of a separate document.

3.2.2 The quality of dental compressed air relative to specific contaminants shall be as per the following referenced limits:

| | Contaminant | Limit |
|---|---|---|
| A. | Water..... | Dry to a pressure dewpoint of 1.6° C (35° F) at not less than 90 psig. |

Reference: American National Standards Institute Standard Z86.1, 1973; and Compressed Gas Association (CGA) Pamphlet G-71.

B. Condensed hydrocarbons..... Not more than 0.1 parts per million (ppm) by weight (wt/wt) or 0.1 mg/L

Reference: CGA Specification G-10.1

C. Permanent particulates..... Less than 1.0 ppm wt/wt or 1.0 mg/L.

Reference: CGA Specification G-10.1

3.2.3 Station pressures of dental compressed air to specified station outlets shall be as follows:

| Designation | Pressure | Tolerance |
|---|---|---|
| DCA 30 | 30 psig | +0, -5 psig |
| DCA 90 | 90 psig | +5, -0 psig |

Pressure tolerances apply at individual centrally piped distribution network station outlet valves at flow rates specified.

3.3 Dental Compressed Air System.

3.3.1 The dental compressed air system shall include, but is not limited to, the following minimum components listed in downstream order:

- Compressor intake filters
- Compressors
- Aftercooler with liquids separator
- Air receiver
- Prefilter
- Dryer
- Afterfilter
- Pressure regulator
- Low pressure monitor and warning device

3.3.2 All cooling, separating, drying, filtering, and regulating system components shall be sized for maximum combined compressor output potential at mean system pressure.

3.3.3 System starts per hour to maintain the standard demand by intermittent duty shall not exceed eight (four starts per hour per compressor).

3.3.4 The system pressure differential shall be not less than 20 psig (1.36 atmospheres).

3.3.5 Compressors.

3.3.5.1 The system shall be provided with two equally sized compressors, duplexed, with provisions for automatic alternate and simultaneous operation depending on demand. Compressors shall operate alternately to

maintain the standard demand and simultaneously to maintain the contingency demand.

3.3.5.2 Each system compressor shall be sized to operate at a 65% duty cycle for maintenance of the standard demand.

3.3.5.3 Compressors shall be rotary types with lubricated chamber and metal rotor and stator components.

3.3.5.4 Individual compressor efficiency shall be not less than 3.5 CFM/horsepower expended.

3.3.5.5 Compressors shall be designed and/or equipped to limit compressor lubricant carryover into compressor output air to less than 10 ppm, wt/wt. Internal or external air/lubricant separators shall be serviceable without major compressor disassembly.

3.3.5.6 For preventive maintenance purposes the system compressors shall be provided with electrical disconnects and manual override switching to permit service on either compressor while standard demand is maintained by the alternate compressor.

3.3.5.7 The system compressors shall be provided with overload protection, motor starting, and all other devices as required by other Air Force dental health facility engineering criteria.

3.3.5.8 System compressor/motor units shall be mounted on resilient vibration isolator pads. Vibration transmission to other parts of the system or to the facility floor shall be limited to less than 5% of the lowest frequency of vibration.

3.3.5.9 Compressor intakes and outlets shall be connected to other parts of the system with flexible hoses or flexible pipe.

3.3.6 Aftercooler With Liquids Separator.

3.3.6.1 The aftercooler shall be an air cooled type.

3.3.6.2 The aftercooler shall be sized to provide output air at mean system pressure not more than -6.6° C (20° F) above ambient air temperatures.

3.3.6.3 The internal design of the aftercooler shall provide continuous gravity drainage of condensates to the liquids separator without clogging of aftercooler air passages.

3.3.6.4 The liquids separator shall be 99% efficient in removal of all condensed liquids and shall be provided with an automatic condensate drain.

3.3.7 Air Receiver.

3.3.7.1 The air receiver shall be an ASME certified pressure vessel suitable for intended use and be provided with pressure-activated

devices for automatic on and off switching of compressors; a pressure gage; a pressure relief valve; an automatic condensate drain; and a manual condensate drain.

3.3.7.2 The air receiver size shall be calculated based on calculated standard demand and specified duty cycle, starts per hour, and system pressure differential.

3.3.7.3 The air receiver shall be of an industry standard, commercially available size. When the calculated size exceeds a standard size by more than 15%, then the next larger standard size shall be used.

3.3.7.4 The air receiver outlet line shall be provided with a manual valve to permit servicing of downstream filters without receiver depressurization.

3.3.8 Filters.

3.3.8.1 Compressor intake filters shall be replaceable dry element types, 100% efficient in retention of solids 40 μm and larger in diameter.

3.3.8.2 Prefilters shall be replaceable cartridge types, 100% efficient in retention of solid and liquid aerosol particulates 1.0 μm and larger in diameter. Prefilter cannisters shall be provided with automatic condensate drains.

3.3.8.3 Afterfilters shall be replaceable cartridge types, 100% efficient in retention of solid and liquid aerosol particulates 0.025 μm and larger in diameter. Afterfilter cannisters shall be provided with automatic condensate drains.

3.3.9 Dryer.

3.3.9.1 The dryer shall be a direct-expansion, noncycling, refrigerated type with air-to-air precool/reheat exchanger and an air-to-refrigerant main exchanger; an automatic condensate drain; and an air-cooled condensor.

3.3.9.2 The dryer refrigerant circuit shall include, but not be limited to, a hot gas by-pass valve; filter(s); accumulator and thermostatic expansion valve.

3.3.9.3 The dryer capacity shall be sufficient for the maximum combined compressor output at mean system pressure, and for the production of air at the specified pressure dewpoint.

3.3.10 Regulator. The system regulator shall be a relieving type with an outlet control range of 0-120 psig, and with a pressure gage on the outlet side with a 0-120 psig pressure range.

3.3.11 Low Pressure Monitor and Remote Warning Device.

3.3.11.1 An air pressure monitoring device shall be connected in the air line between the system afterfilter and the system regulator.

3.3.11.2 The monitor shall be equipped with an audible alarm and a test button. The monitor shall be adjusted and connected to activate the audible alarm and the remote warning when system pressure falls below the minimum specified.

3.3.11.3 The labeled low pressure remote warning device shall be located in the administration/records/reception area of the dental clinic.

3.3.12 System Interconnections.

3.3.12.1 Unless otherwise specified, all system interconnecting piping shall be type "K" or "L" seamless copper tubing, washed and degreased. All valves and fittings shall be wrought copper, brass, or bronze. All joints shall be made with silver brazing alloy except for valves or equipment requiring threaded pipe connections. Threaded pipe connections shall be made by tinning male threads with soft solder.

3.3.12.2 System interconnections and components shall be suitable for not less than 125 psig working pressure and shall be tested with dental compressed air or nitrogen to 180 psig.

3.4 Centrally Piped Distribution Network.

3.4.1 All pipe, fittings, and connections shall be as per paragraph 3.3.12.1.

3.4.2 The centrally piped distribution network branches shall be suitable for not less than the following working pressures and shall be tested with dental compressed air or nitrogen to the pressures indicated:

| Branch Designation | Working Pressure Suitability (psig) | Test Pressure (psig) |
|---|---|---|
| 30 | 50 | 60 |
| 90 | 125 | 180 |

3.4.3 In-line regulators shall be used for reduction of DCA 90 to DCA 30 in locations or groups of locations where required. In-line regulators shall be relieving types with an outlet control range of 0-60 psig and with a pressure gage on the outlet side with a 0-60 psig pressure range.

3.4.4 Network station outlets shall terminate in one of three valve types relative to the valve outlet side configuration as follows:

- Type I: Manual valve with 3/8-in. compression stop outlet.
- Type 2: Manual valve with 3/8-in. FPT outlet.
- Type 3: Ground cock, blade handle, labeled manual valve with hose barb outlet to accommodate 1/4-in. i.d. hose.

3.4.5 Network station outlet valves are required in one of two mounting configurations as follows:

- Mounting 1: In-line, suspended by riser stub to which attached.

- Mounting 2: Surface mounted, flanged to penetrated surface.

3.4.6 Network pipe sizes, in-line regulators and station outlet valves shall be adequate to provide station pressures and flow rates to equipment specified as follows:

| Station Pressure Designation | Flow Rate (CFM) | Station Valve (Type/Mounting) | Equipment Served | Equipment J.S.N |
|---|---|---|---|---|
| DCA 90 | 3 | 1/1 | All DTR utility centers | D7090 |
| | 4 | 2/1 | Pneumatic laboratory handpieces | D4261 |
| | 4 | 2/2 | Micro air abrasive units | D9015 |
| | 4 | 2/2 | Sand/shell air abrasive units | D9010 |
| | 4 | 2/2 | Pneumatic laboratory chisels | D4590 |
| DCA 30 | 1 | 1/2 | Pneumatic laboratory presses (small)<br>(large) | D4320<br>D4310 |
| | 3 | 3/2 | Casting/soldering torches | T9100M |
| | 3 | 2/2 | Air guns | D9995 |

4. SYSTEM SIZING

4.1 Standard Demand.

The standard demand for dental compressed air for each dental facility shall be calculated as follows (new construction scoped to DOD criteria and existing facilities):

Standard Demand = Number of DTRs x 1.0 CFM

4.2 Contingency Demand.

The contingency demand for dental compressed air for any dental facility shall be calculated as follows:

Contingency Demand = Number of DTRs x 1 CFM x 2

4.3 Compressor Size.

Each individual system compressor shall be sized to provide a system duty cycle not to exceed 65% per the following calculation:

$$\frac{SD}{0.65} = ICO$$

Where:

SD = Standard demand

ICO = Individual compressor output in CFM at mean system pressure

4.4 Air Receiver.

The air receiver size shall be calculated to maintain the established standard demand within the parameters specified for duty cycle, starts per hour and system pressure differential as follows:

$$RS = \frac{OT \times 7.48 \times SD}{8 \times 1.36} = \frac{157 \times SD}{10.88}$$

Where:

RS = Receiver size in gallons

OT = System off time based on 65% duty cycle (21 min)

7.48 = Gallons per cubic foot

SD = Standard demand

1.36 = System pressure differential (atmospheres)

3 = System starts per hour

Note: Nominal industry standard receiver sizes (gallons) are 80, 120, 400, and 600 (see para. 3.3.7.3).

5. DOCUMENTATION

5.1 Instructions. The contractor shall supply two complete sets of the manufacturer's operating and maintenance instructions as specified in paragraph 5.2 to the local maintenance organization who shall be responsible for system maintenance. Bound set covers shall be labeled with the system name, building number, contractor's name, and contract number.

5.2 General Information. The manual shall include an overall description and purpose of the system or equipment. The function and purpose of

each system component shall be described. The description shall include the intended use, capabilities, and limitations of the system or equipment. If the manual covers more than one model of a system or equipment, or systems or equipment modified by field change, a description of the differences shall be provided. Quick reference data shall be included and shall describe technical or design characteristics of the equipment. Examples of such data are:

- Descriptive (nameplate) data necessary to identify manufacturer, type, and model.

- Functional characteristics, such as: power and frequency requirements, voltage and amperage demands, outputs, and modes of operation.

- Rated outputs, such as: horsepower, cubic feet per minute, and revolutions per minute.

- Special characteristics, such as: operating temperatures, pressure, heat dissipation, and humidity.

5.2.1 A warning page, consisting of the more vital warnings extracted from those shown throughout the manual, shall be assembled and placed on the inside cover or in front of the initial page(s) of the manual (See 5.2.6).

5.2.2 Operating instructions shall include routine and emergency procedures (manual and automatic) and safety precautions. Limits to be observed in the starting, operating, stopping, or shutting down of the equipment or system shall be provided. Adequate illustrative material shall be provided to identify and locate operating control and indicating devices. The function of each operating control and indicating device shall be included. Emergency operating instructions shall include alternate procedures to be followed when normal operation is not possible because of emergency conditions, such as power or lubricating oil failure. Emergency operating instructions and procedures shall be located for quick and ready reference.

5.2.3 Preventive maintenance information shall be provided. Use of special tools, materials, and test equipment shall be specified, including model/type designation, as appropriate. The following procedures shall be stressed, if applicable:

5.2.3.1 Periodic cleaning and lubrication information, types of cleaning agents or lubricants required, recommended intervals, such as monthly, quarterly, semiannually, or hours of operation shall be provided. Application points and capacity (required amounts) shall be identified. Pictorial format for lubrication is desirable. Cleaning and lubrication required during repair, replacement, and reassembly shall also be covered (See 5.2.5).

5.2.3.2 Instructions for inspection of equipment for damage and wear shall be included. Tabular or chart format is preferred and shall include, where applicable, allowable service limits, wear, backlash, end play, length and depth of scoring, and balance. These instructions shall be

sufficiently complete to serve as standards by which experienced technicians may determine when parts may be continued in use and when they must be replaced.

5.2.3.3 Instructions shall be included for verification of system performance. The location of test connections and the values expected at these points shall be included, preferably in illustrated format. Data shall include a list of equipment required to accomplish the verification, such as temperature, vacuum, pressure, hydraulic, or pneumatic gages.

5.2.4 Failures that might occur during operation of equipment shall be listed. Troubleshooting data and fault isolation techniques shall state: (a) the indication or symptom of trouble, (b) the instructions necessary, including test hookups, to determine the cause, (c) special tools and equipment, and (d) methods for returning the equipment to operating conditions. Information may be in chart or in tabular format with appropriate headings.

5.2.5 Instructions shall be provided for all removal, repair, adjustment, and replacement procedures. Exploded and sectional views giving details of assemblies shall be provided, as necessary, to clarify the text. For mechanical items, dimensional information with tolerances, clearances, wear limits, maximum bolt-down torques, and in-place balancing or other means of reducing noise level, if required, shall be supplied.

5.2.6 Notes, cautions, and warnings shall be used to emphasize important and critical instructions where necessary. Notes, cautions, and warnings shall immediately precede the applicable instructions, and shall be selected as follows:

NOTE: Concerns an operating procedure or condition which should be highlighted.

CAUTION: Concerns an operating procedure or practice which, if not strictly observed, could result in damage to, or destruction of equipment.

WARNING: Concerns an operating procedure or practice which, if not strictly observed, could result in injury to personnel or loss of life.

5.2.7 Manuals shall contain all illustrations necessary to locate and identify components of operational and maintenance significance. Where necessary for clarity, illustrations shall show configuration and the removal and disassembly of parts. The following types of diagrams shall be included: schematic diagrams which show the arrangement of component devices or parts; wiring diagrams which show the connections of the circuit arrangement; and schematic piping diagrams which show the interconnection of components, of piping, tubing, or hose, and the direction of air flow.

5.2.8 Circuit diagrams for electronic units shall be provided to support maintenance and troubleshooting. Circuit diagrams shall cross-reference repair parts shown in test tables and parts lists. The function name of each stage or circuit, primary signal flow, test points, wave forms with pertinent characteristics, electrical characteristics of parts, name of

each variable control, input and output connectors/terminals voltages and signals shall be specified. Voltage and resistance values measured with controls set for normal operation shall be shown for significant points, such as terminal boards and connectors. Interconnecting cable diagrams shall be furnished to show TO-FROM information, including any intermediate connections. Block diagrams shall be provided to support installation instructions, but shall not be substituted for necessary schematic diagrams.

5.2.9 Parts lists shall provide positive identification of parts necessary for support of the systems or equipment and shall include sufficient information to enable maintenance personnel to requisition replacement parts. Clear and legible illustrations shall be provided to identify component parts and parts' relationships. Part numbers and part names may be shown on illustrations or separately listed. When the illustrations omit the part numbers and part names, both the illustrations and separate listings shall cross-reference illustrated part to listed part.

5.3 Format.

5.3.1 Wherever possible, commercial manuals will be incorporated without change in either content or format. The commercial manuals may be bound without disassembly in the facility manual, or may be disassembled and applicable portions incorporated into existing manuals.

5.3.2 The manual may be divided into volumes to prevent the manual from becoming too bulky.

5.3.3 The manual shall be oriented toward operation, maintenance, and repair of the equipment by the operator and maintenance personnel without the assistance of a manufacturer's representative.

5.3.4 The text shall be specific, concise, and clearly worded to be easily understood by personnel involved in the operation, maintenance, and repair of the equipment.

5.4 Manuscript Review. Draft manuscript copies, in the format and number as specified, shall be provided to the Government for review (See 5). Operating and maintenance procedures, including checkout, calibration, alignment, scheduled removal and replacement instructions, and associated checklists shall be validated against the system (or equipment) in the presence of Government personnel.

5.5 Posted Instructions. Besides the operation and maintenance manuals, the following diagrams and instructions shall be furnished and installed, framed under glass or approved plastic laminate, and permanently posted within view of the installed system:

- Complete layout diagram to include all wiring, controls, system components, plumbing, valves, and regulators.
- Selective starting and stopping procedures.
- Checking procedure for normal operation.

- Abbreviated recommended preventive maintenance procedures.
- Emergency instructions.
- Warnings and precautions.

5.6 Field Instructions. After installation, startup, testing, and acceptance of the system, the contractor shall be required to supply the services of a competent representative for not less than 4 h to instruct local maintenance and operating personnel in the proper operation and maintenance of the complete system.

## 6. CONCLUSIONS

This report includes the minimum requirements for central dental compressed air systems (DCA) and associated centrally plumbed distribution networks for use in USAF dental health facilities. These specifications are interim until joint evaluations by the Dental Investigation Service and the Occupational and Environmental Health Laboratory establish standards for dental clinics. Any questions should be directed to USAFSAM/NGD, Brooks AFB, TX 78235-5301, AUTOVON 240-3502, commercial (512) 536-3502.

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